行政院國家科學委員會專題研究計畫　成果報告

含部分欠撥和退化之兩個售價及批量存貨模式的比較

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執行期間：93 年 08 月 01 日至 94 年 07 月 31 日
執行單位：淡江大學管理科學研究所

計畫主持人：歐陽良裕

計畫參與人員：鄧進財　陳良和

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中文摘要

最近，Abad（2003）討論了退化性產品在有限生產率、指數退化率、部分欠撥和銷售損失下的售價和批量問題。他的模式是週期開始時即生產，由於生產率大於需求率，存貨逐漸累積；當存貨數量達到某一水準時，便停止生產。接著，庫存量隨著市場的需求及退化逐漸減少並產生缺貨現象；此時，只有部分顧客願意等待欠撥。當欠撥數量達到某一水準時，便又開始生產，缺貨數量逐漸被補足。本研究，我們首先將推廣他的模式，在目標函數中加入欠撥成本和商譽損失成本。接著，對相同的售價和批量問題，我們建立一個類似於 Goyal and Giri（2003）的新模式。此模式是週期開始時不生產，造成缺貨，而只有部分顧客願意等待欠撥，當欠撥數量達到某一水準時，便開始生產，缺貨數量逐漸被補足，接著產生存貨。當存貨數量累積到某一水準時，便停止生產，庫存量隨著市場的需求及退化，逐漸降至零為止。我們以分析的方法比較這兩個模式的總利潤，並且指出在某些條件下，其中一個模式優於另一個模式。最後，舉一些例子說明上述的結論。

關鍵詞: 存貨、售價、部分欠撥、退化性產品

Abstract

Recently, Abad (2003) discussed the pricing and lot-sizing problem for a perishable good under finite production, exponential decay, partial backordering and lost sale. His production-inventory model starts with an instant production to accumulate stocks, then stops production to use up inventory, and finally restarts production to meet the unsatisfied cumulative demands. In this study, we will first extend his model by adding not only the backlogging cost but also the cost of lost goodwill into the objective. Next, we will establish a new modeling approach, which is similar to Goyal and Giri (2003) modeling approach. Namely, the production-inventory cycle begins with a period of shortages, and then starts

production until accumulated inventory reaches a certain level, and finally stops production and uses up inventory. We then will analytically compare the total profits between these two distinct models. In addition, we will provide certain conditions under which one is more profitable than the other. Finally, we will also give several numerical examples to illustrate the results.

Keywords: Inventory; Pricing; Partial Backlogging; Deteriorating Items

Source and purpose

Many researchers have studied inventory models for deteriorating items such as volatile liquids, blood banks, and medicines. Ghare and Schrader (1963) firstly proposed an exponentially decaying inventory model. They categorized decaying inventory into three types: direct spoilage, physical depletion and deterioration. Next, Covert and Philip (1973) extended Ghare and Schrader's constant deterioration rate to a two-parameter Weibull distribution. Misra (1975) developed an economic order quantity (i.e., EOQ) model with a Weibull deterioration rate for a perishable product but he did not consider backordering. Shah and Jaiswal (1977) and Aggarwal (1978) presented and re-established an order level inventory model with a constant rate of deterioration, respectively. Dave and Patel (1981) considered an EOQ model for deteriorating items with time-proportional demand when shortages were prohibited. Sachan (1984) then generalized the EOQ model to allow for shortages. Later, Hariga (1996) generalized the demand pattern to any log-concave function. Teng et al. (1999) and Yang et al. (2001) further generalized the demand function to include any non-negative, continuous function that fluctuates with time. Recently, Papachristos and Skouri (2003) extended Wee's (1999) deteriorating EOQ model with quantity discount, pricing and partial backordering to allow for the demand rate to be a convex decreasing function of the selling price.

Abad (1996) established the optimal pricing and lot-sizing EOQ policies under conditions of perishability and partial backordering. Then Abad (2000) extended the optimal pricing and lot-sizing EOQ model to an economic production quantity (i.e., EPQ) model. Balkhi and Benkherouf (1996) developed a general EPQ model for deteriorating items where demand and production rates are time varying, but the rate of deterioration is constant. Balkhi (2001) then further generalized the EPQ model to allow for a time-varying deterioration rate. Concurrently, Yan and Cheng (1998) considered a perishable single-item EPQ model in which production rate, demand rate and deterioration rate are assumed to be functions of time, and shortages are partially backlogged. Lately, Yang and Wee (2003) established a multi-lot-size EPQ model for deteriorating items with constant production and demand rates. Other recent articles related to this research area were written by Abad (2001), Chang and Dye (1999), Papachristos and Skouri (2000), Skouri and Papachristos (2003), Teng et al. (2002), and Wee and Law (1999). In addition, Raafat (1991), and Goyal and Giri (2001) wrote two excellent surveys on the recent trends in modeling of continuously deteriorating inventory.

Recently, Abad (2003) studied the pricing and lot-sizing problem for a perishable

good under finite production, exponential decay and partial backordering and lost sale. He assumed that customers are impatient and the backlogging rate is a negative exponential function of the waiting time. In addition, he assumed that the customers are served on first come first served basis during the shortage period. Then he provided a solution procedure to obtain the optimal price and lot-size that maximizes the average profit. However, he did not include the shortage cost for backlogged items and the cost of lost goodwill due to lost sales into the objective. If the objective does not include these two costs, then it will alter the optimal solution and overestimate the average profit. To correct them, in this study, we will add both the shortage cost for backlogged items and the cost of lost goodwill due to lost sales into the objective suggested by Abad (2003).

In Abad (2003), the production-inventory model starts with an instant production to accumulate stocks, then stops production to use up stocks, and finally restarts production to meet the unsatisfied cumulative demands. In fact, Abad's production-inventory model is similar to that in Balkhi and Benkherouf (1996). Lately, Goyal and Giri (2003) investigated a similar production-inventory problem in which the demand, production and deterioration rates of a product were assumed to vary with time. However, pricing was not under consideration and the backlogging rate was assumed to be a constant fraction. They then proposed a new production-inventory model in which the cycle begins with a period of shortages, then starts production until accumulated inventory reaches a certain level, and finally stops production and uses up inventory. Finally, Goyal and Giri (2003) provided a numerical example to show that their model outperforms Balkhi and Benkherouf's model (1996) in terms of the least expensive total cost per unit time.

In this study, we will first extend Abad's (2003) pricing and lot-sizing model by adding not only the shortage cost for backlogged items but also the cost of lost goodwill due to lost sales into the objective. Next, we will establish a new modeling approach as in Goyal and Giri (2003) to the same pricing and lot-sizing inventory problem. We then will characterize the optimal solution to both distinct models, and obtain some theoretical results that show the conditions under which one model is more profitable than the other. Finally, we will provide several numerical examples to illustrate the results, and draw the conclusions.

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Self-evaluation

This research corresponds to the original plan and has attained its aim. Hence, the study is of great academic value and suitable for publication in academic journals. It is now being submitted to International Journal of Production Economics.